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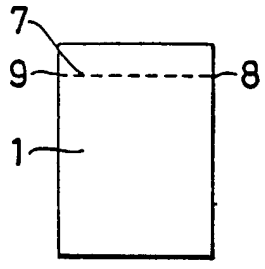

(57) Abstract

A method of reading a valuable document which, in conjunction with its manufacture, has placed on or embodied in the document substratum, such as its paper when applicable, at least one continuous optical fibre (7), the two end surfaces (8, 9) of which are both located at the edge of the document (1). Light-emitting devices are caused to illuminate the first and the second surface of the fibre or fibres, and light-sensitive devices are caused to detect whether or not the end surface of the fibre, or the end surfaces of respective fibres, emits or emit, light when illumination and/or detection takes place at one or more pre-determined locations on the document. The invention also relates to a valuable document having placed on or incorporated in the document substratum, such as paper when appropriate, at least one continuous optical fiber (7), the two end surfaces (8, 9) are both located at the edge of the document (1), each fibre being arranged to conduct light emitted at the first end surface (8) of the fiber to its second end surface (9). The invention also relates to an arrangement for reading valuable documents in accordance with the method.

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A method of reading valuable documents; a valuable document; and document reading means.

The present invention relates to a method of reading or examining valuable documents and to a valuable document and document reading means.

The term valuable document as used here refers primarily to bank-notes, although it will be understood to include other documents, such as passports, share certificates, bonds, bankers cards, etc.

With regard to valuable documents or papers, such as bank-notes for example, it is traditional to print thereupon a complicated design or pattern, a guilloche design, in order to make forgery of the document difficult and to enable it to be established whether the document is genuine or false. The paper from which the document is produced is also often of a particular quality and provided with a watermark. These and similar characteristics of a valuable document are intended as means by which a person is able to ascertain, primarily visually, whether the document is false or genuine. The task of deciding whether or not a document is genuine is relatively difficult to carry out, even for those who are relatively skilled in such matters. Consequently, it is necessary to scrutinize carefully valuable documents, such as bank-notes, passports, in order to establish whether the document is genuine or whether it is a clever or qualified forgery.

One desideratum of long standing in this respect is the ability to establish whether a document is genuine or false with the aid of mechanical devices. This is particularly true in the case of bank-notes, so that forged bank-notes can be automatically sorted out by a machine. The same desideratum prevails, however, in respect of other forms of valuable documents occurring in large

quantities, such as bond certificates, lottery tickets, etc.

There is also an expressed need for determining mechanically and rapidly whether each individual document of a number of documents is genuine or not. Thus, a significant advantage would be afforded if it were possible to establish whether, for example, a bank-note or passport was genuine or not with the aid of mechanical means.

A further need is one of enabling bank-notes to be counted mechanically, without first needing to sort the bank-notes into their respective denominations. Correspondingly, there is also the need of being able to identify purely mechanically a bank-note, e.g. with respect to its denominational value, when the bank-notes receiving arrangement is intended to receive bank-notes of mutually different denomination. Such arrangements may also be intended to receive bank-notes of different currencies as well as different denomination.

Known so-called cash points, autobanks, and like cash dispensers are designed to detect one or more different bank-note denominations, by measuring the size of the bank-note and/or its permeability to light, at different areas of the bank-note. These apparatus are primarily encumbered with the drawback that only one or two bank-notes can be identified in this respect by one and the same apparatus, and that a soiled bank-note may have a negative influence on the machine, causing the bank-note to be rejected.

The present invention affords a solution to these problems, and enables all the aforesaid desiderata to be fulfilled.

Thus, the present invention relates to a method for reading or examining valuable documents, which is charac-

terized in that when producing the valuable document there is placed on or incorporated in the document substratum, where applicable its paper at least one continuous optical fibre whose two end surfaces are both located at a given edge of the document; and in that light emitting or transmitting means are caused to illuminate a first end surface of the at least one optical fibre; and in that a light-sensitive device is caused to detect whether or not light is emitted from the other end of the at least one optical fibre, this illuminating and/or detecting process being carried out at one or more predetermined locations on the document.

The invention also relates to a valuable document capable of being read in accordance with the method and which is characterized in that the document substratum, such as paper where applicable , has located thereon or incorporated therein at least one continuous optical fibre, the two end surfaces of which are both placed at a given edge of the document; and in that each fibre is arranged to conduct light emitted at the first end surface of the fibre to its second end surface.

The invention also relates to an arrangement for carrying out the aforesaid method, this arrangement being characterized in that light-emitting devices are arranged to illuminate one end surface of a respective optical fibre; and in that light-sensitive devices are provided for detecting light conducted through respective fibres; and in that said light-emitting and/or said light-sensitive devices are arranged to illuminate respective optical fibres and to detect light emitted therefrom at predetermined locations on the document.

The present invention will now be described in more detail, partly with reference to various embodiments of the invention illustrated in the accompanying drawing.

In the following description of the invention the valuable document is referred to as a bank-note, although it will be understood that the described embodiments of the invention apply equally as well with any form of valuable document.

In the accompanying drawing:
Figures 1-6 illustrate different examples of the positioning of one or more optical fibres, placed on or incorporated in a valuable document.

Figure 7 is a schematic illustration of a reading arrangement according to the invention.

In Figures 1-6 there is illustrated a valuable document 1-6 according to the invention, which is exemplified by a bank-note. The document is provided with at least one continuous optical fibre 7, which is placed on or incorporated within the document substratum. In Figures 1-6 the fibres are shown in broken lines, since the optical fibres of these embodiments have been embedded within the substratum. By document substratum is meant here, and in the following, the material, or one of the materials, from which the valuable document is comprised. Thus, with valuable paper documents, the term substratum refers to the actual paper itself. Although in accordance with the invention the optical fibre can be placed on or affixed to the document, i.e. attached to one of the surfaces of the document, it is preferred to embed or incorporate the optical fibre within the body of the substratum. When the optical fibre is embedded in the substratum in conjunction with its manufacture, it is extremely difficult, if not impossible, to subsequently change the position of the fibre, to insert new fibres, or to exchange existing fibres for fibres of other optical characteristics or properties.

The optical fibres used may be of any suitable kind, such as glass fibres and particularly optical plastic fibres.

The first end 8 and the second end 9 of the optical fibre are located at the edge of respective documents 1-6. The fibre 7 is intended to conduct light which is emitted or applied to the first end surface 8 of the fibre, to its second end surface 9, where the light emitted can be detected, as described in more detail hereinafter. The end surfaces of the fibre 7 are thus not embedded in the document substratum.

In accordance with one preferred embodiment exemplified in Figure 2, one or more fibres 10, 11 extend between mutually different edges 12,13 and 12,14 of the document 2.

In another preferred embodiment exemplified in Figure 3, one or more fibres 15,16 extend inwardly from one edge 17 of the document and back to the same edge 17. As illustrated in Figure 3, this fibre arrangement can be combined with a fibre arrangement in which a fibre 18 extends between two mutually opposed edges 17,19 of the document 3.

It is obvious that an infinite number of variations are to be found with regard to the positioning of one or more optical fibres on or in the document substratum, and hence the illustrated fibre positions shall be considered solely as an exemplification.

In accordance with a further embodiment, different kinds of the same type of document, such as bank-notes of different denomination of a currency of a particular country, are provided with one or more fibres, of which the respective first ends 8 and second ends 9 thereof are placed at a given distance apart or at predetermined positions in relation to the document, therewith indicating the value of the bank-note. A Swedish 10-Kronor bank-note, a 50-Kronor bank-note and a 100-Kronor bank-note can be mentioned as an example of what is meant in this respect. Each of these bank-notes may be provided with, for example, two optical fibres which extend across

the whole width of the bank-note, as illustrated in Figure 1. In this instance the two fibres are placed, for example, parallel with one another, with the specific spacing between the fibres of respective bank-notes corresponding to a 10-Kronor note, a 50-Kronor note and a 100-Kronor note respectively.

By illuminating the first end surface of respective fibres and placing a photo-sensitive device at each of the locations of respective second end surfaces of the fibres placed on or in the various bank-notes, the photo-sensitive devices are activated in dependence on the mutual distance between the fibres, i.e. in dependence on the value of the bank-note.

Figures 4-6 illustrate a further exemplifying embodiment, in which the document referenced 4 may be a 10-Kronor bank-note, the document referenced 5 a 50-Kronor bank-note, and the document referenced 6 a 100-Kronor bank-note. In this case the document 4 has a single fibre 20, the document 5 has two fibres 21,22 and the document 6 has three fibres 23,24,25. The fibres 20,21 and 23 are placed at the same distance from the one short side 26 of respective documents. The fibres 22 and 24 are also placed at the same distance from the short side 26. Reading of the different bank-notes is exemplified below in conjunction with the following description of the arrangement illustrated in Figure 7.

Naturally, all the fibres used may have precisely the same optical characteristics. However, in accordance with one embodiment of the invention there are used fibres which possess mutually different characteristics with respect to their ability to conduct light of different wavelengths and/or at different luminous flux.

Consequently, in accordance with one embodiment of the invention one or more fibres are colored. When using

colored optical fibres, there are used light-sensitive means which are influenced essentially by light emitted solely from one such colored fibre.

In another embodiment the light-conducting fibres are of mutually different diameters, therewith enabling mutually different fibres to conduct a mutually different maximum luminous flux from a given light source. Consequently, in this case, the luminous flux of the light emitted by the different fibres will vary. This variation in luminous flux is utilized by arranging for the photo-sensitive devices to produce an electric signal which varies commensurately with the luminous flux of the light striking the device in question, this signal being processed in a detector circuit 40 in order to establish whether or not the luminous flux of the light received lies within a given, predetermined value or range, given partly by the intensity of the light emitted from the light emitting device to the first end surface of the fibre, and partly by, inter alia, the diameter of the fibre.

Depending upon application, the diameter of respective fibres may vary and be suitably selected for each particular document. For example, the diameter may be from 1/100th of a mm up to 1 mm.

The present invention also relates to a method for reading a valuable document of the aforesaid kind which has been provided, in manufacture, with at least one continuous optical fibre located on or incorporated in the document substratum. In accordance with this method light emitting devices, 27,28,29 are caused to illuminate the first end surface 8 of the fibre 7, or of the respective fibres, and light-sensitive devices 30,31,32 are caused to detect whether or not light is emitted from the second end surface 9 of the fibre, or of the respective fibres, this illumination and/or detection being effected at one or more predetermined locations on the document.

In accordance with one preferred embodiment of the invention, applicable with the aforedescribed embodiment of a valuable document which includes one or more fibres which have optical characteristics different to those of the remaining fibres, the aforesaid light-emitting devices are arranged to emit light of mutually different intensity and/or wavelength in different fibres. In this case, the light-sensitive devices are caused to detect the presence of such light at the second end surfaces of respective fibres.

The method according to the invention will now be described in more detail with reference to an arrangement for reading valuable documents and forming part of the present invention.

Figure 7 is a highly schematic illustration of an exemplifying embodiment of an arrangement according to the invention.

In Figure 7 there is shown a valuable document 5, which may correspond to the bank-note illustrated in Figure 5, which has fibres 21,22 extending directly thereacross. The reference 33 designates an infeed device, which may comprise two mutually adjacent rolls arranged to convey the bank-note 5 in the direction of the arrow 34. A position-indicating device comprising for example photo-cells 35,36 is located at a given distance from the light-emitting devices 27-29 and the light-sensitive devices 30-32, which are positioned on a respective side of a bank-note transport path. When the bank-note has been advanced to a position in which its leading edge 37 breaks the path of the light from both photo-cells, this position being illustrated in Figure 7, an indication is given to the effect that the bank-note occupies a predetermined position in relation to the arrangement in general. The light-emitting devices 27-29 and the light-sensitive devices 30-32 are so positioned in relation to the photo-cells 35,36 that when the bank-note occupies the afore-

said predetermined position light is emitted, or transmitted and, when present, is detected at predetermined locations on the document, namely when the document is genuine and incorporates optical fibres in accordance with the invention. The bank-note can be advanced continuously. When the light paths of both photo-cells 35,36 are broken, the cells send a signal to a gate 38, which in turn sends a signal to a control circuit 39, which ignites the light-emitting devices 27-29 in response thereto. When a fibre is located in front of a light-emitting device, the fibre will conduct the light emitted from said device to its other end surface, from where it is emitted to the corresponding light-sensitive device. This will emit a signal to a detector circuit 40 arranged to detect from which light sensitive element that a signal is received. The detector circuit is also arranged to detect therewith whether or not the document incorporates one or more fibres at predetermined locations. In the simplest case this decides whether the bank-note is genuine or not.

In another case the signals sent to the detector 40 may also constitute information concerning the value of the bank-note. The bank-note 5, which in the aforegoing is said to be a 50-Kronor bank-note is used in the illustration of Figure 7. In this case the detector receives a signal from the devices 30 and 31, in accordance with the aforegoing, through the two fibres 21,22, but receives no signal from the device 32. Upon receiving these signals the detector is operative, in the absence of a signal from the device 32, to send a signal to a further device, such as a data processor 41, a lamp or some other visual display means, indicating that the bank-note 5 is a 50-Kronor bank-note.

Correspondingly, when the bank-note referenced 4 in Figure 4 is fed into the arrangement, a signal is obtained solely from the device 30, whereupon the detector 40 sends to the data processor 41 a signal which indicates that the bank-note is a 10-Kronor bank-note. In a corresponding manner the bank-note referenced 6 in Figure 6 gives rise to a

signal from all devices 30-32, wherewith the detector sends to the data processor 41 a signal which indicates that the bank-note is a 100-Kronor bank-note.

When the arrangement receives a bank-note having no fibres which coincide with the location of a light-emitting or light-sensitive device when the light paths or beams of the photo-cells 35,36 are broken is indicated as a forgery. The detector 40 receives a signal from the control circuit 39 when said circuit ignites the light-emitting devices 27-29. In the absence of a signal from the light-sensitive devices the detector sends to the data processor 41 a signal indicating that the bank-note is a forgery. This also applies when a signal is received solely from fibres having a position corresponding to the positions of the fibres 22,24,25.

According to a preferred embodiment, the aforesaid light-emitting devices 27-29, 39, are arranged to transmit light of different intensity and/or wavelength in mutually different fibres, the corresponding light-sensitive devices 30-32, 40 being arranged to detect the presence of such light at the second end surfaces 9 of respective fibres.

With regard to the intensity of the light transmitted, one or more light-emitting devices 27-29 can be arranged to transmit light of a higher intensity. In this respect, the corresponding light-sensitive element may be arranged to send an electric signal to the detector 40 solely when receiving light of sufficient intensity, or alternatively the device may be arranged to send a signal to the detector 40 in dependence on the light intensity, the detector 40 in this case being arranged to detect the amplitude of the signal and therewith determine whether or not the light received has a sufficiently high intensity.

With regard to wavelengths, the light-emitting or light-transmitting devices may be arranged to transmit light

of wavelengths different to the wavelength of visible light, for example infrared light. In this case, corresponding light-sensitive devices are arranged to send a signal to the data processor 41 when receiving infrared light.

In accordance with one of the aforementioned embodiments the fibres comprise a colored material. In this embodiment the light-emitting devices for example are arranged to transmit visible white light. The light-sensitive devices, on the other hand, are arranged to send a signal solely when the light received by the light-sensitive device has assumed a particular wavelength contingent on the color of the fibre. This can be achieved by selecting a known light-sensitive device which is more sensitive to one or a number of light wavelengths than to other light wavelengths. Alternatively the light emitted from the aforesaid second end surface of a respective fibre can be filtered prior to impinging on the light-sensitive element, by inserting a suitable known optical filter in front of the light-sensitive device.

The aforementioned light-emitting or light-transmitting devices incorporate light-emitting elements such as light diodes or the like. The aforementioned light-sensitive devices incorporate photo-transistors or corresponding light-sensitive semiconductors.

As will be understood, it is necessary to adjust the arrangement illustrated schematically in Figure 7 with regard to the positioning of the light-emitting and light-sensitive devices in relation to the positioning of the fibres in the document. Examples of different fibre positions are illustrated in Figures 1-6.

Thus, it will be readily understood that the present invention is not solely restricted to mechanically determining whether or not a bank-note or some other valuable

document is genuine, but also enables a valuable document to be identified with respect to a certain characteristic, by utilizing a plurality of optical fibres and associated light-emitting and light-sensitive devices. In this regard the arrangement can be incorporated in a cash dispenser, autobank, for analyzing the value of a bank-note. The arrangement can also be used for sorting bank-notes or other valuable documents.

A document-reading arrangement of the aforedescribed kind can be arranged to read documents, one by one, such as passports for example. For example, a number of fibres can be incorporated in one or more pages of a passport, which when the passport is placed in a reading arrangement of the aforesaid kind indicates whether the passport is genuine or not.

The fibres can be positioned in a manner to form a code.

Documents other than paper documents can also be provided with fibres in accordance with the present invention. For example, a credit card can be provided with fibres in order to enable its validity to be established. In this respect, fibres can be placed in a credit card at given mutual distances apart in a manner to form a code relating to a maximum credit limit, the expiry of the credit card, etc., similar to the aforedescribed arrangement of fibres in bank-notes for determining the denominational value thereof.

It will be evident from the aforegoing that the present invention meets all of the desiderata mentioned in the introduction. In addition, a document which incorporates optical fibres in accordance with the invention is extremely difficult to forge.

It will also be understood that the present invention can be applied with any form of valuable document, and that

the aforedescribed exemplifying embodiments can be modified without departing from the concept of the invention.

The invention is therefore not restricted to the aforedescribed embodiment, and modifications can be made within the scope of the following claims.

CLAIMS

1. A method for reading a valuable document, characterized by providing the valuable document, in conjunction with its manufacture, with at least one continuous optical fibre placed on or incorporated in the substratum of the document, where appropriate its paper, such that the two end surfaces of the at least one optical fibre are located at an edge of the document; by causing light-emitting devices to illuminate the first end surface of the fibre, or fibres; and by causing light-sensitive devices to detect whether or not the second end surface, or end surfaces, of the fibre, or fibres, emit light when illumination and/or reading is effected at one or more pre-determined locations on the document.

2. A method according to Claim 1, characterized in that said light-emitting devices are caused to transmit light of different intensity and/or wavelength in different fibres, and by causing the light-sensitive devices to detect the presence of such light at the second end surface of a respective fibre.

3. A valuable document, characterized in that the document substratum, such as paper where applicable, has placed thereon or incorporated therein at least one continuous optical fibre (7; 10; 15,16; 20-25) the two end surfaces (8,9) of which are both placed at an edge of the document (1-6), each fibre being arranged to conduct light transmitted to the first end surface (8) of the fibre to its second end surface (9).

4. A valuable document, characterized in that the optical fibre or optical fibres (7; 10; 15,16; 20-25) is, or are, totally embedded in the substratum of the document (1-6) with the exception of the two end surfaces (8,9) of the fibre or fibres.

5. A valuable document according to Claim 3 or Claim 4, characterized in that one or more fibres (7,10; 20-25) extend between two mutually different edges (12,13; 17,19) of the document (2;3).

6. A valuable document according to Claim 3,4 or 5, characterized in that one or more fibres (15,16) extend from one edge (17) of the document (3) and back to the same edge (17).

7. A valuable document according to Claim 3,4,5,or 6, characterized in that in the case of each type of document the first and/or second end surface (8,9) of the optical fibre or respective optical fibres (7,10;15,16;20-25) are placed at a predetermined distance apart or at predetermined locations in relation to the document (1-6).

8. A valuable document according to Claim 3,4,5,6 or 7, characterized in that one or more fibres (7,10; 15,16; 20-25) have optical characteristic which deviate from the characteristics of remaining fibres present in the document substratum with respect to the light conductivity of the fibres at different wavelengths and/or different luminous fluxes for a given light source.

9. A valuable document according to Claim 8, characterized in that one or more fibres (7,10; 15,16; 20-25) have a larger diameter than other fibres present in the document substratum, the coarser fibres being arranged to conduct a higher luminous flux than the thinner fibres.

10. A valuable document according to Claim 8 or 9, characterized in that one or more fibres (7,10; 15,16; 20-25) is, or are, produced from a colored material.

11.An arrangement for reading a valuable document according to the method defined in Claim 1, characterized in that light-emitting devices (27-29; 39) are arranged to illu-

minate one end surface of a respective optical fibre (7,10; 15,16; 20-25); in that light-sensitive devices (30-32; 40) are provided for detecting light conducted by a respective fibre; and in that said light-emitting and/or said light-sensitive devices are arranged to illuminate and detect respectively at pre-determined locations on the document (1-6).

12. An arrangement according to Claim 11, characterized in that the light-emitting devices (27-29, 39) are arranged to transmit light of different intensity and/or different wavelength in mutually different fibres (7,10; 15,16; 20-25); and in that corresponding light-sensitive devices (30-32,40) are arranged to detect the presence of such light at the second end surface (9) of respective fibres.

13. An arrangement according to Claim 11 or 12, characterized in that said light-emitting devices include light diodes (27-29) or light elements; and in that said light-sensitive devices include photo-transistors (30-32) or like devices, each of which is connected to a detector circuit (40) arranged to compare the signal received from respective photo-transistors (30-32) with a pre-determined value.

Fig.1

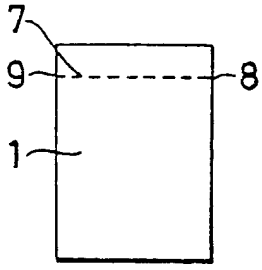


Fig.2

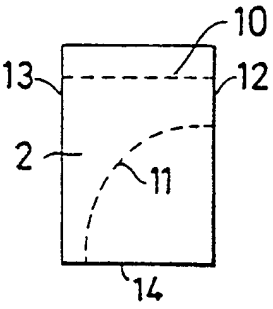
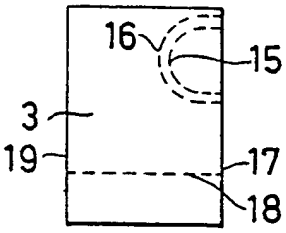


Fig.3



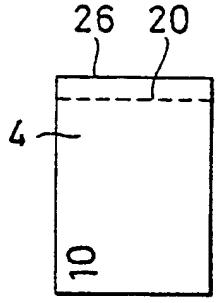


Fig.4

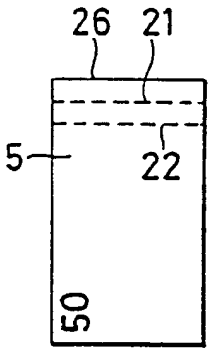


Fig.5

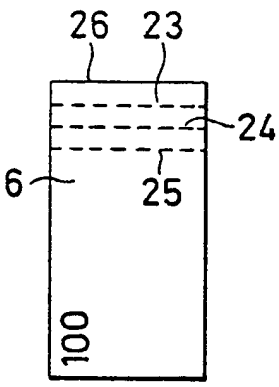
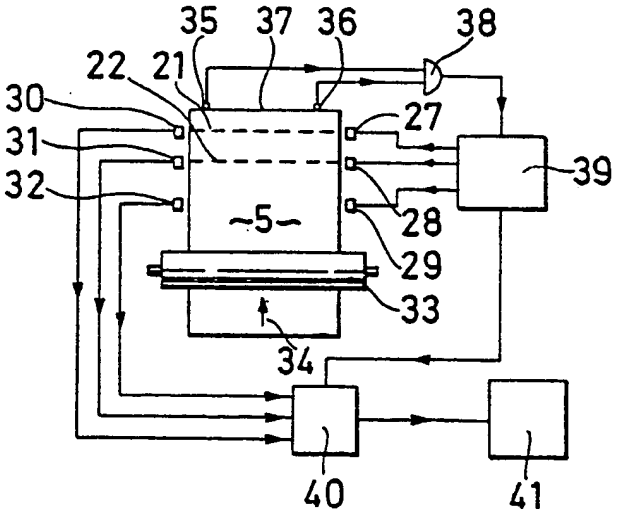


Fig.6

Fig.7



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE86/00138

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [8]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

G 07 D 7/00, B 44 F 1/12

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	G 07 D 7/00; B 44 F 1/12; G 07 C 11/00
US Cl	194:4; 209:111.7; 250:556; 427:7

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A1, 0 037 507 (AGFA GEVAERT AG) 14 october 1981	3

[10] Special categories of cited documents:

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1986-08-29	1986 -09- 17
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Swedish Patent Office	Magnus Westöö